

Dynamic Query

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Switching for Complex Event

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Processing on FPGAs

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Target system

Applications: Real-time data processing

Financial trading



NW traffic analysis

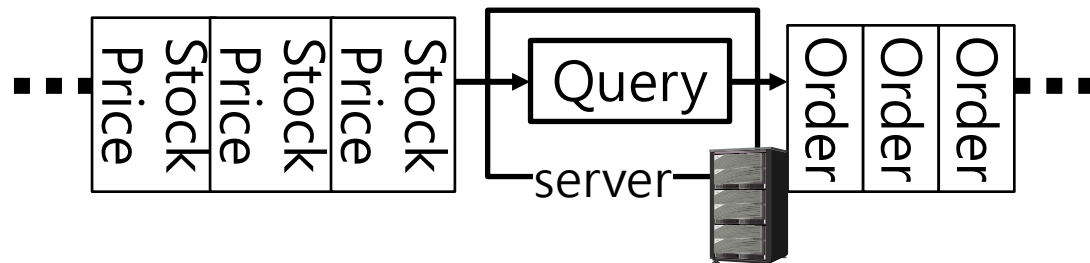


Health care

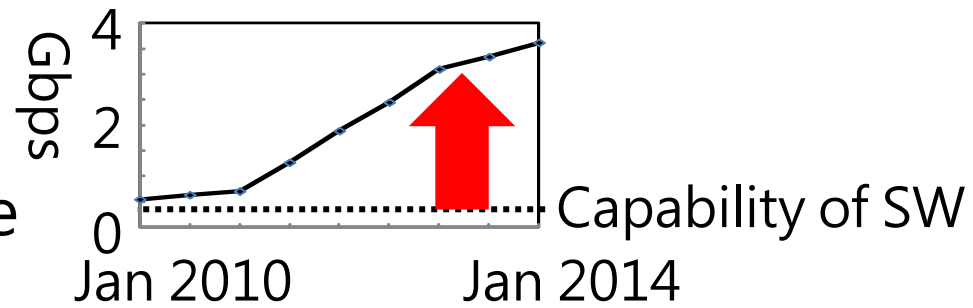


Employed: Complex Event Processing

- Complex event processing (CEP) is a new computing paradigm to deal with it
- CEP handles series of data on-the-fly

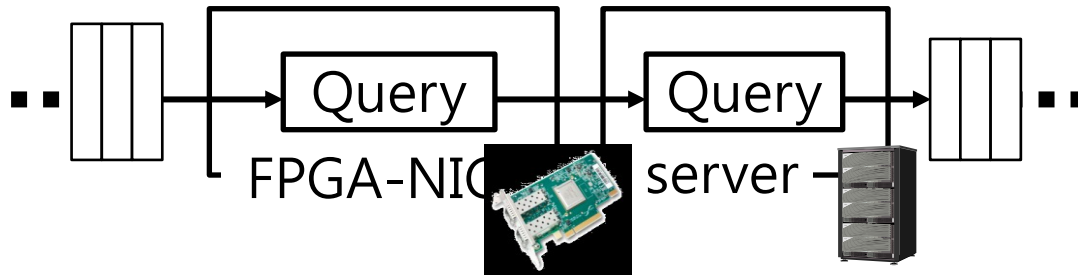


Throughput requirement has surpassed capability of software



Throughput requirement of exchange (based on OPRA prediction)

Target System: FPGA-based Complex Event Processing



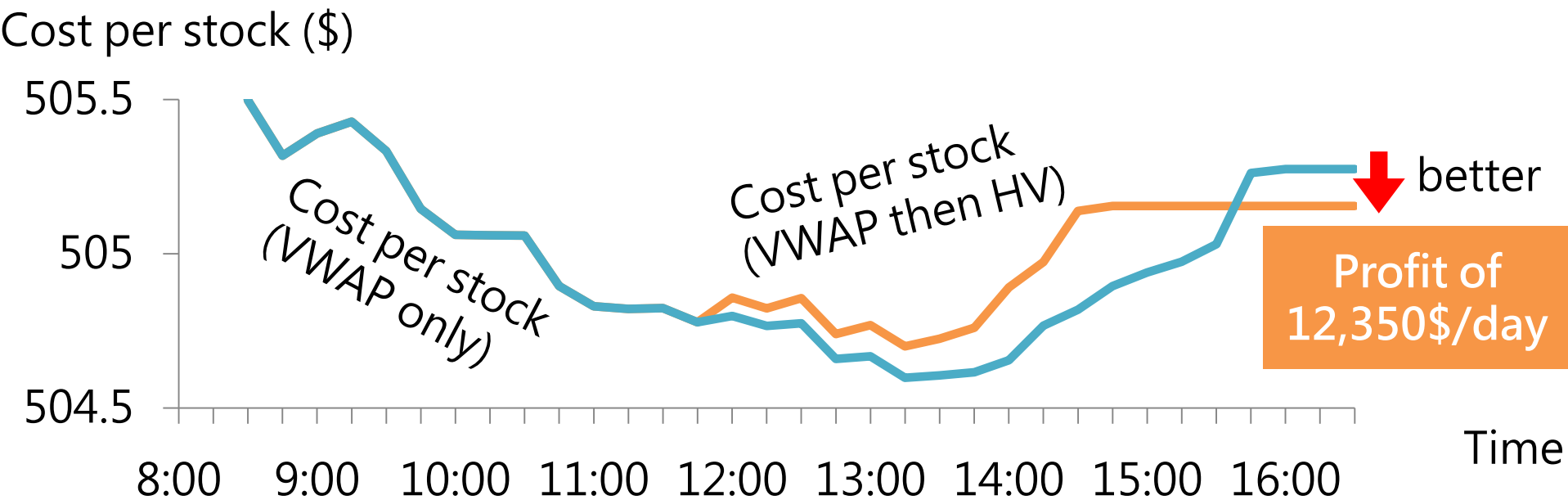
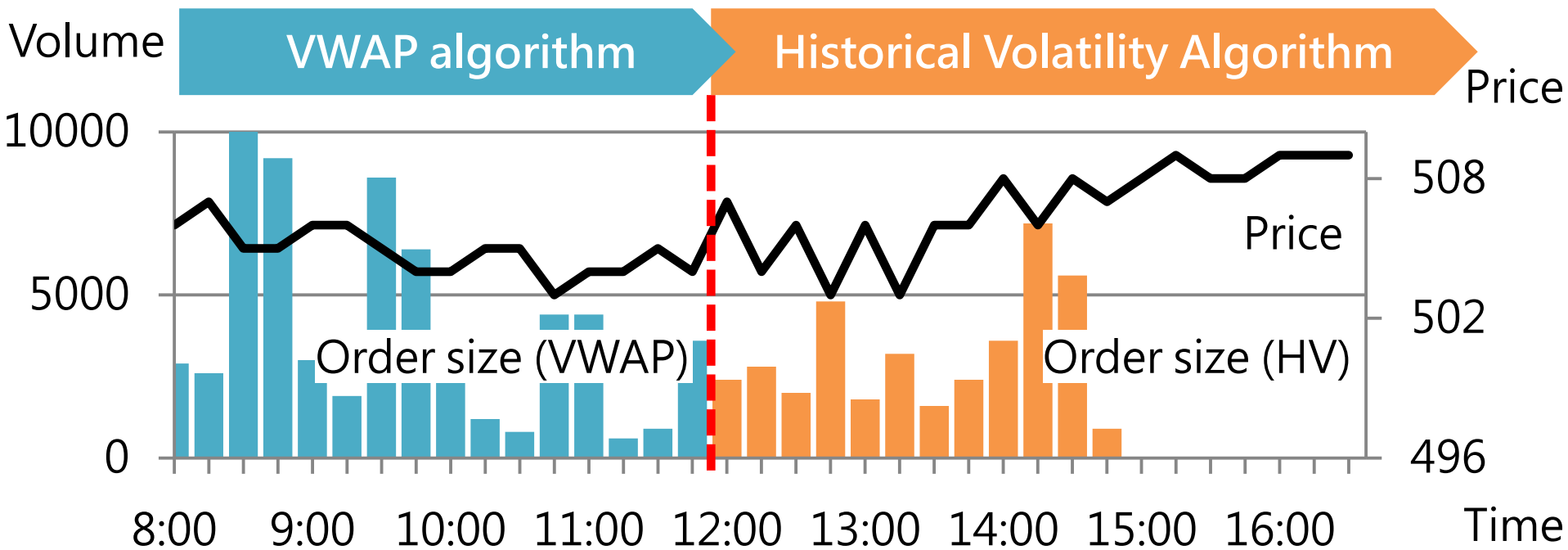
Functions to develop

Requirements for FPGA-based CEP

- i. Reduce loss by Increasing reliability, availability and serviceability
Example: Remove buggy trading query to prevent loss
- ii. Increase profit through changing functions at run-time
Example: Switch to most appropriate trading queries

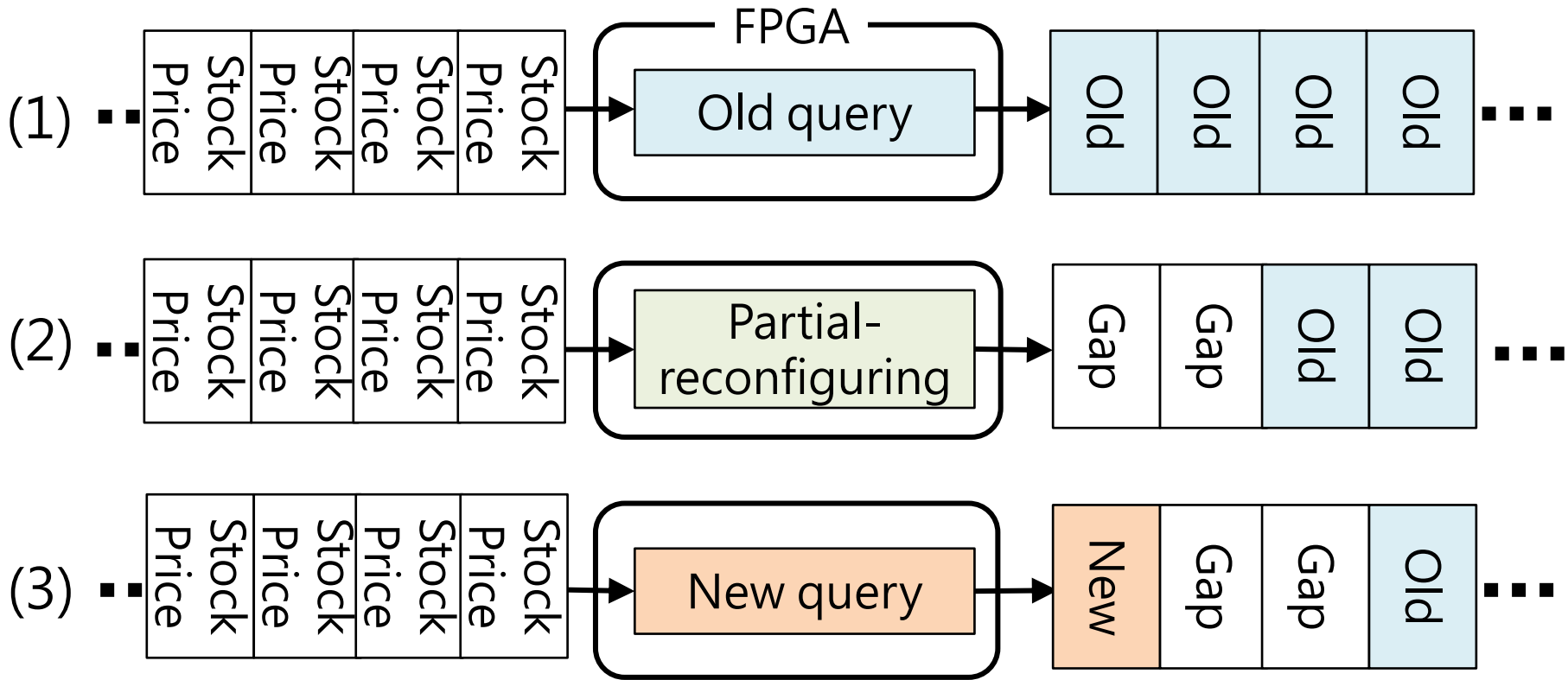
Function to develop: Online query switch
Replacing functions at run-time

Motivating example – Switching trading algorithms



Issues of conventional technique

Writing new query by partial reconfiguration



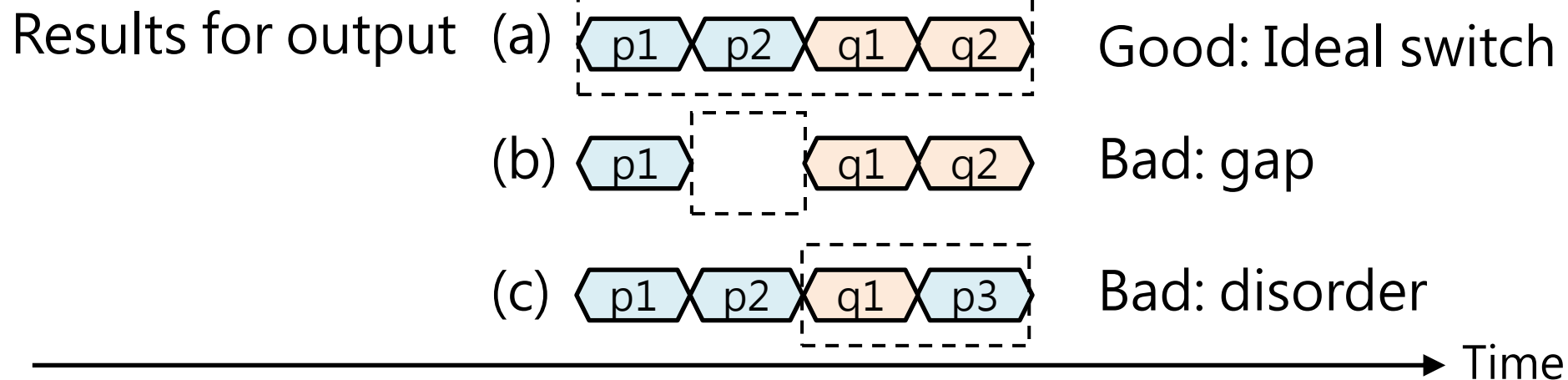
1. Server shutdown is required, OR
2. Inconsistent outputs during switch

Requirements 2: Consistent outputs

1. No gap
2. Old results and new results are not disordered

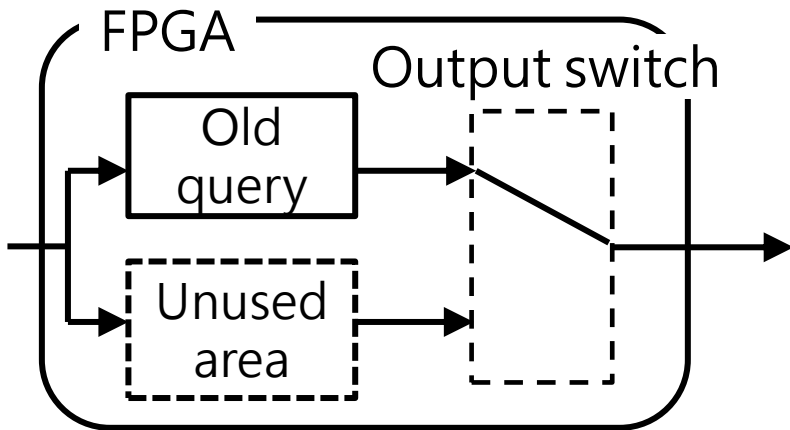
Results of old query 

Results of new query 

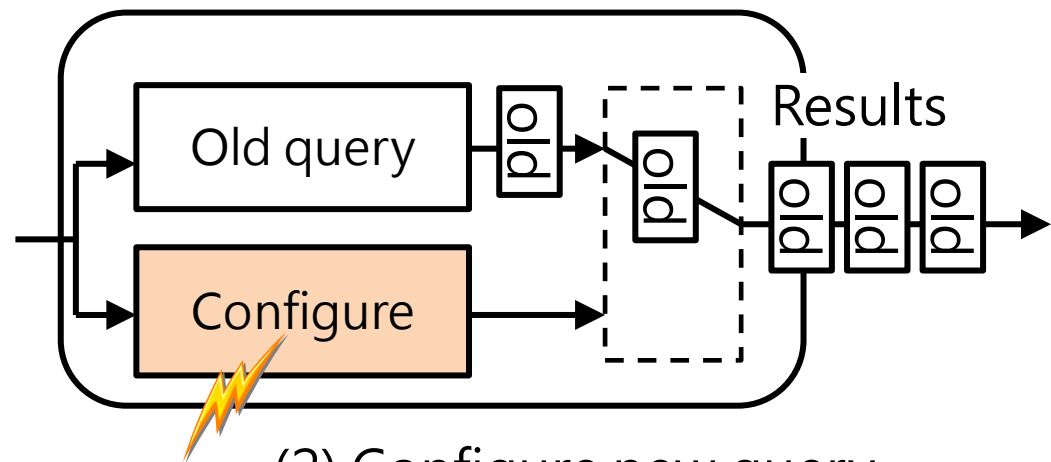


Approach

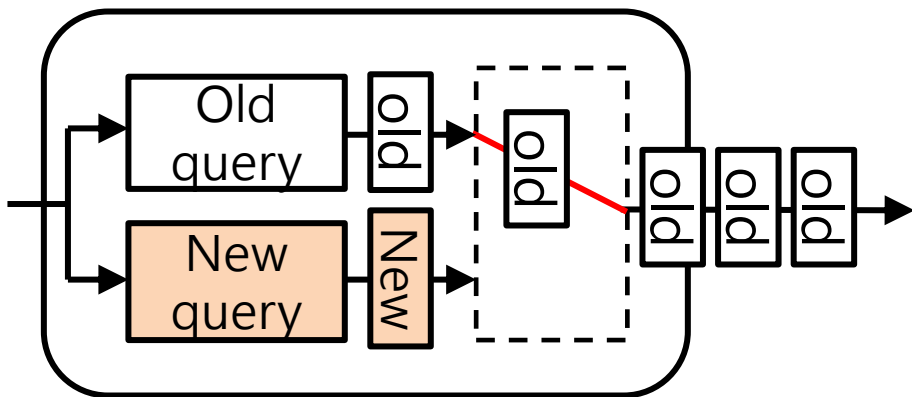
1. Running old and new query simultaneously
2. Select new query results in a timely manner



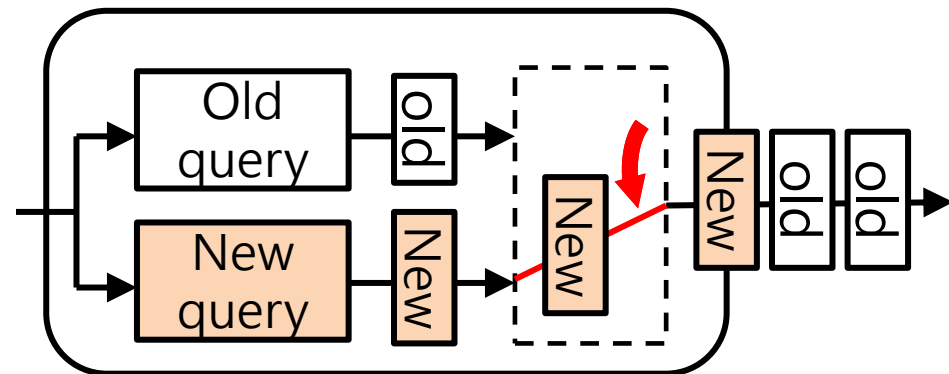
(1) Run old query



(2) Configure new query

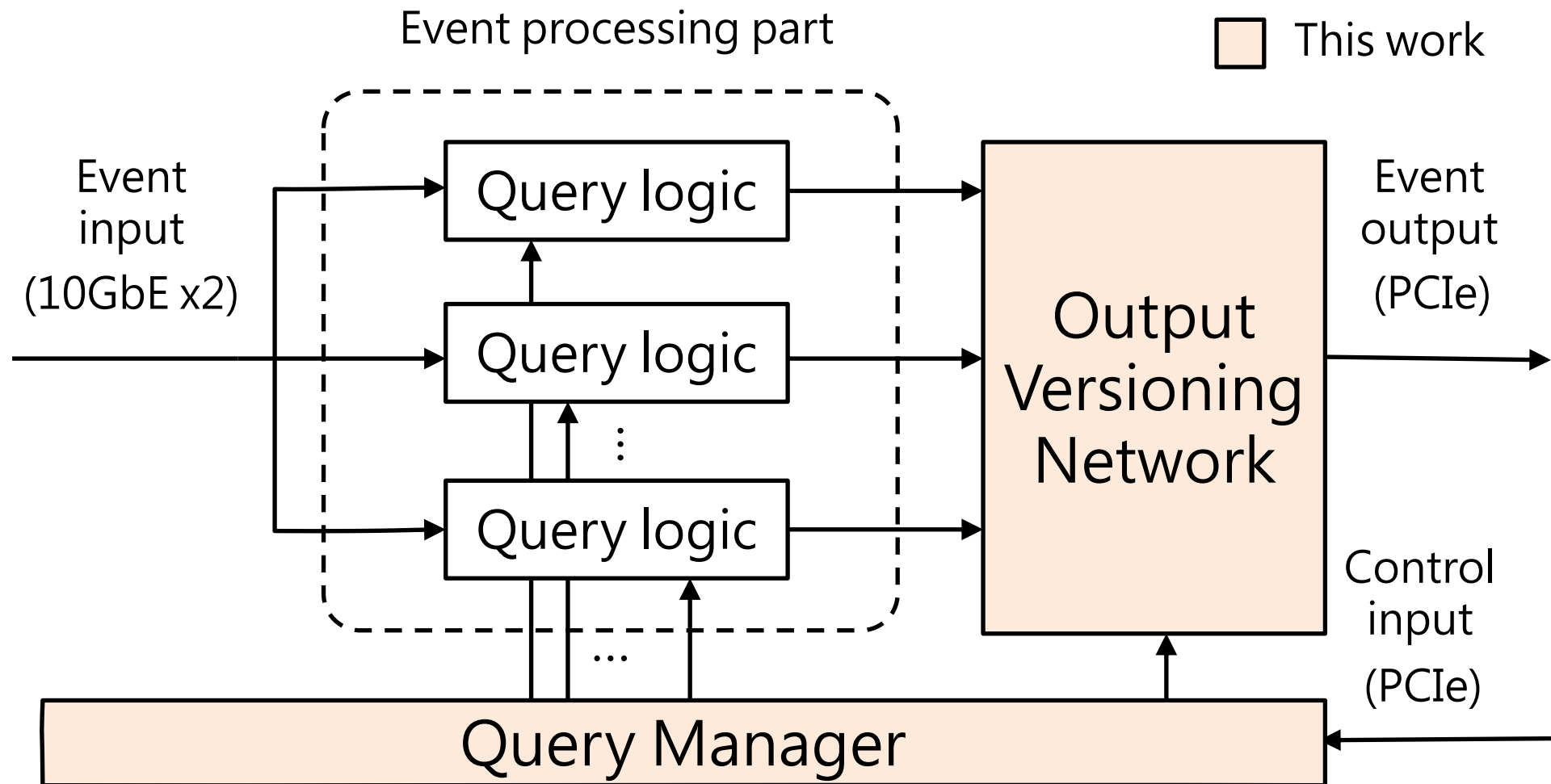


(3) Run new and old query in parallel

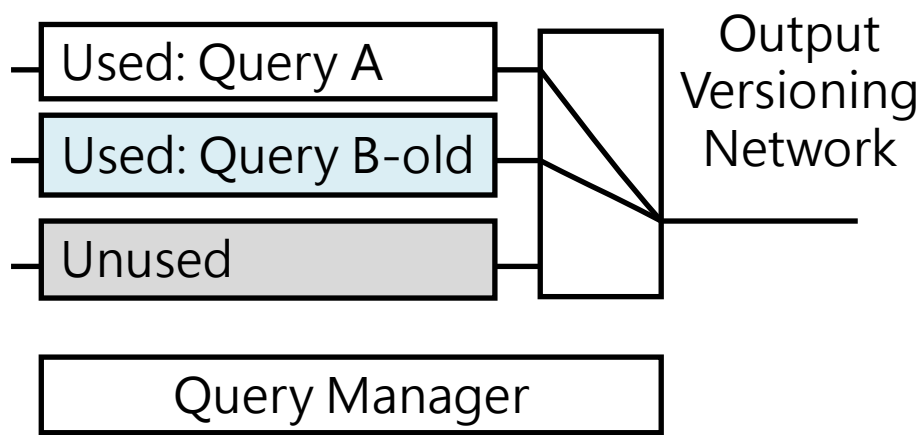


(4) Select and output new results

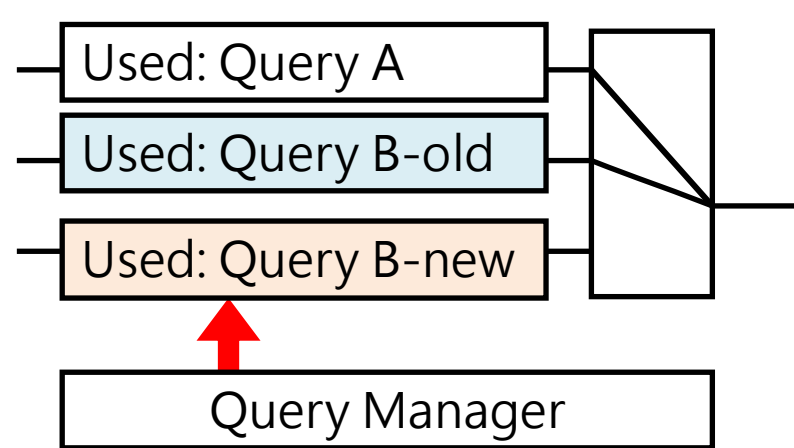
Architecture of Dynamic Reconfigurable CEP



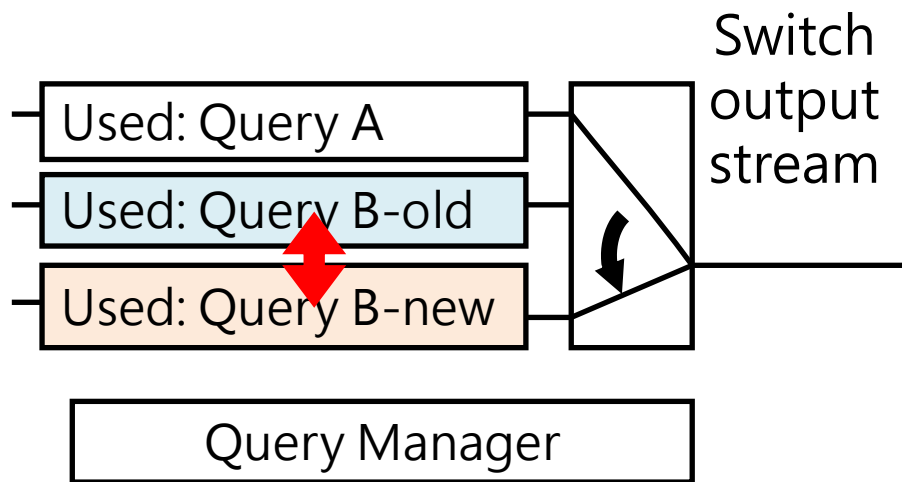
Function of Query manager



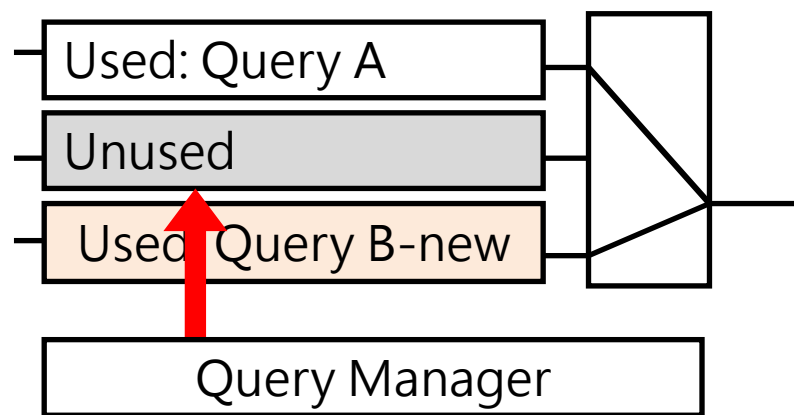
(a) Manage logic area usage and prepare unused area



(b) Configure new query and startup module



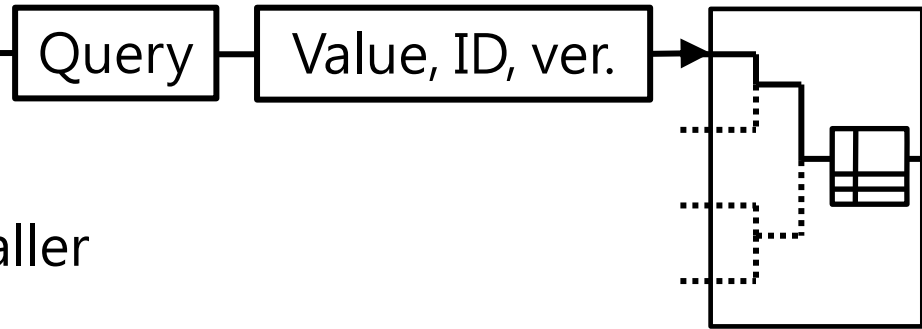
(c) Make old query and new query in parallel



(d) Stop and reclaim logic

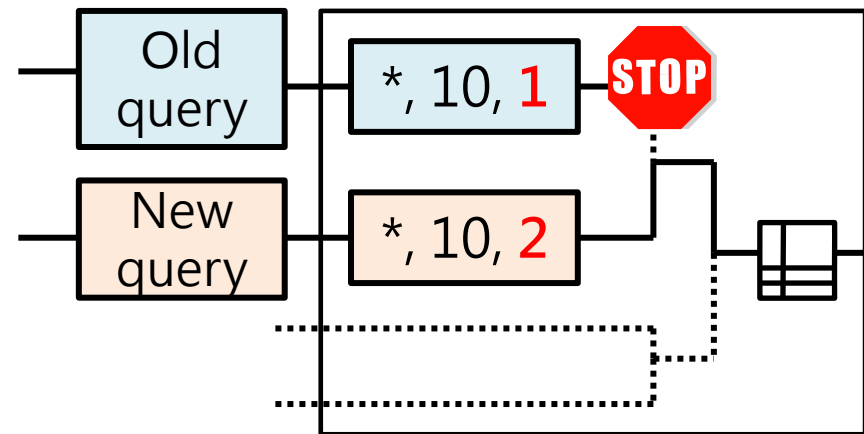
Function of OVN

- (1) Attach query ID and version number to query result

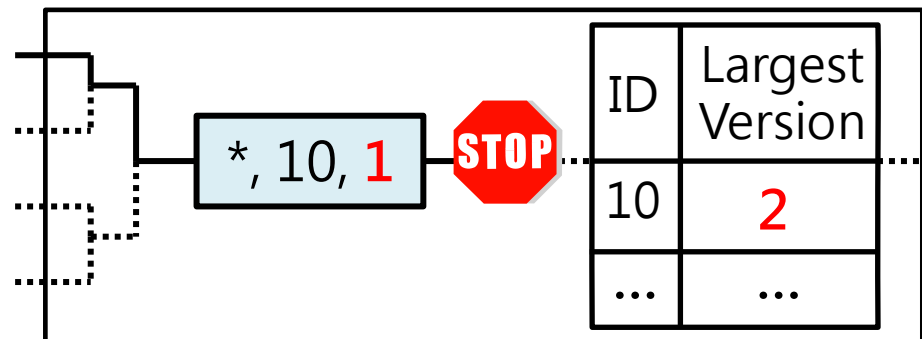


Old query has the same ID as, smaller version number than new query

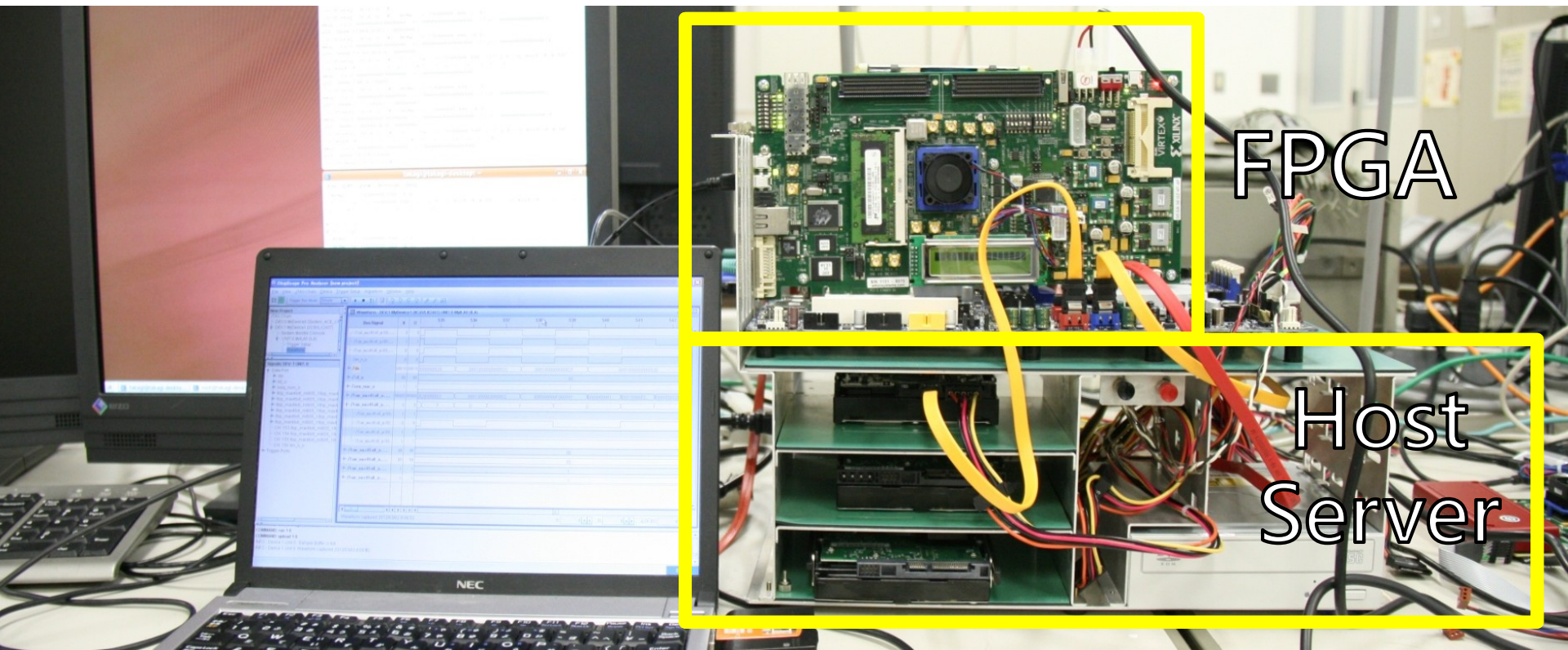
- (2) Drop results with smaller versions by comparing version numbers of two results which meet in the merge tournament



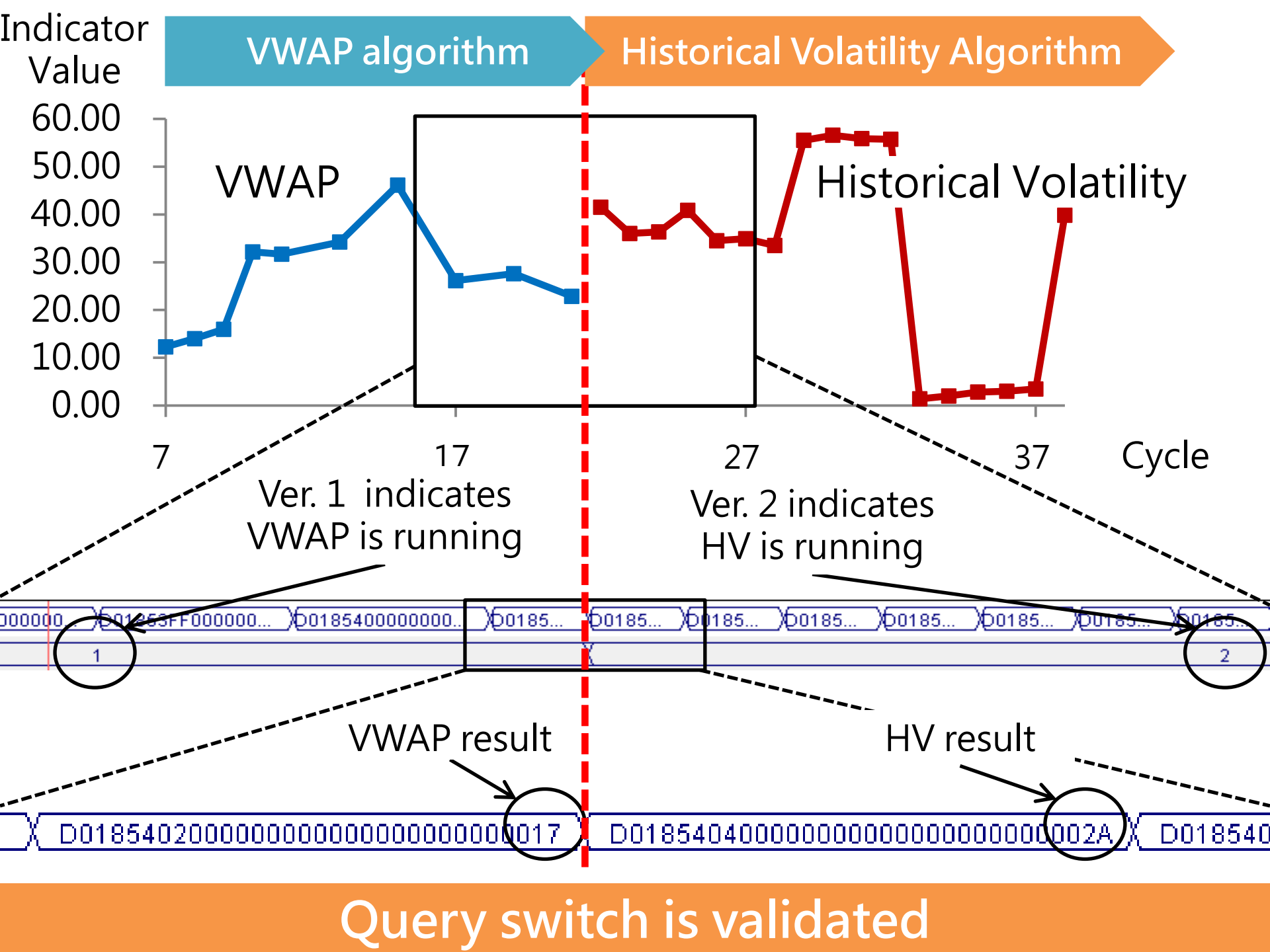
- (3) Drop remaining results with smaller versions by consulting record of largest version ever passed



Test system for Dynamic Reconfigurable CEP

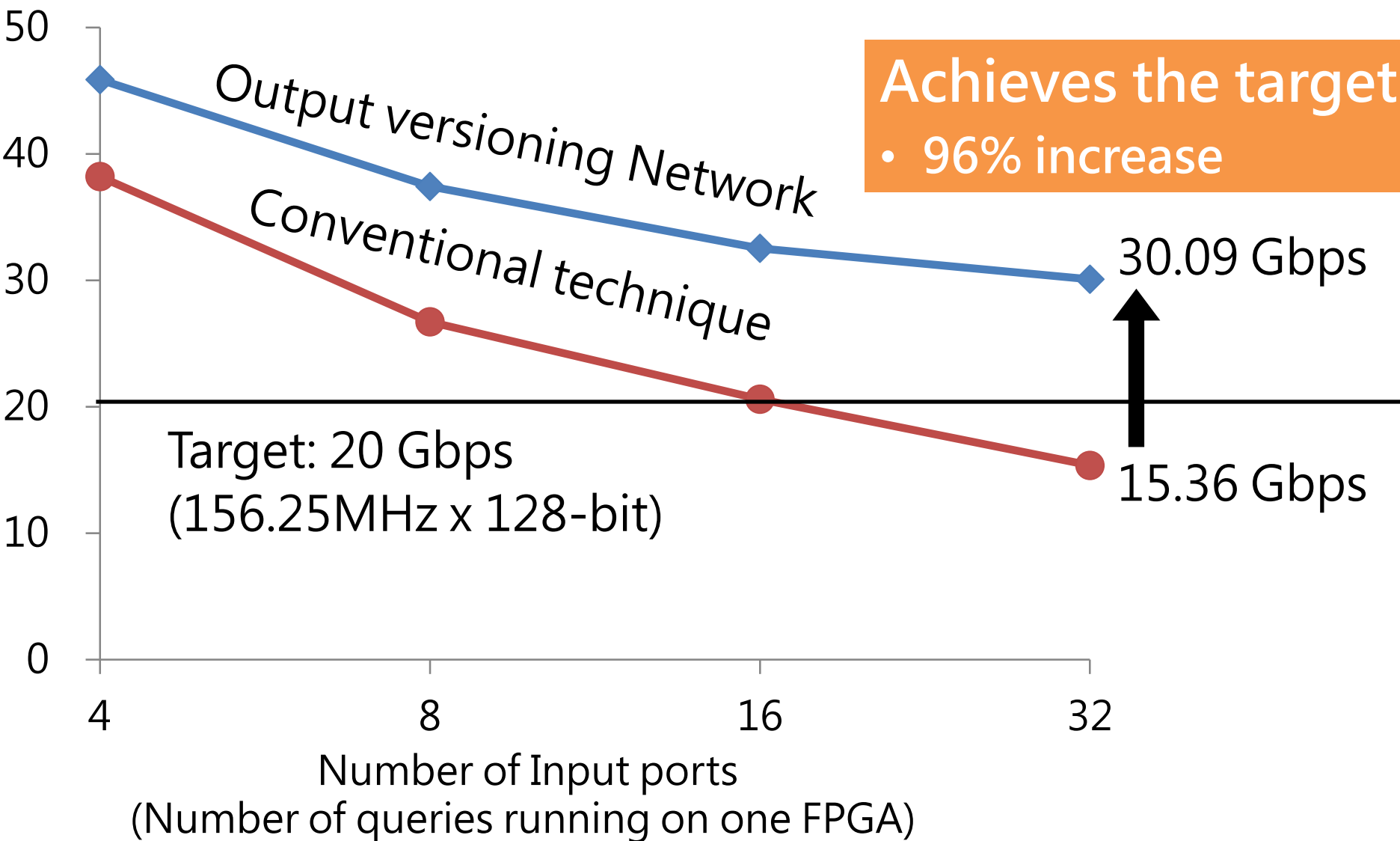


Evaluation of online query switch



Throughput of Output Versioning Network

Throughput (Gbps)



Summary

1. Online query switch on FPGA-based CEP system is developed
 - Server shutdown is not allowed
 - Outputs during query switch should be consistent
2. Query Manager and Output Versioning Network is proposed to solve the consistency issue
 - Run old query and new query in parallel
 - Select results to output from old and new query results in a timely manner
3. Online query switch is validated on FPGA board
4. OVN achieves target clock frequency